



IDENTIFYING DATA

Milk science and technology

Subject	Milk science and technology			
Code	001G041V01704			
Study programme	Grado en Ciencia y Tecnología de los Alimentos			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Galician			
Department				
Coordinator	Centeno Domínguez, Juan Antonio			
Lecturers	Centeno Domínguez, Juan Antonio			
E-mail	jcenteno@uvigo.es			
Web				
General description	Learning the subject "Dairy Science and Technology" aims to provide specific skills to the student to: Know the composition and the most important physicochemical properties of milk from the technological point of view; State the factors that may affect the quality of milk as a raw material for the dairy industries; Describe the fundamentals and peculiarities of the processes of preservation and diversification of milk; Know the equipment used in the dairy industry for the transformation of milk and the production of different dairy products; and Analyze and evaluate risks, and manage safety in the dairy industry. The subject, of mandatory type, is related horizontally with five other subjects taught in the fourth year of the degree, all of them named by the ending "... Science and Technology" (Meat, Fishery Products, Vegetables, Cereals and Wine).			

Training and Learning Results

Code	
A2	Students will be able to apply their knowledge and skills in their professional practice or vocation and they will show they have the required expertise through the construction and discussion of arguments and the resolution of problems within the relevant area of study.
B1	Students will acquire analysis, synthesis and information-management skills to contribute to planning and conducting research activities in the food field.
B4	Students will be able to adapt to new situations, become highly creative and have ideas to take up leadership positions.
C1	To know the physical, chemical and biological foundations of food and its technological processes.
C2	To be familiar with the chemistry and biochemistry of food and of its associated technological processes.
C6	To be familiar with the industrial processes linked with the processing and transformation of food.
C7	To be familiar with the basic concepts linked to hygiene through the whole process of production, transformation, preservation and distribution of food. This involves the acquisition of the relevant knowledge about food microbiology, parasitology and toxicology, as well as contents linked to personal hygiene, products and processes.
C13	Ability to analyze food.
C14	Ability to control and optimize processes and products.
D4	Independent-learning and information-management skills.
D5	Problem-resolution and decision-making skills.

Expected results from this subject

Expected results from this subject	Training and Learning Results
FROG1: To describe the phases and components of milk from the physical and chemical points of view inferring their relationship with technological aptitudes, in addition to the most important factors of variation of the composition of milk	C1 C2
FROG2: To know the properties of technological interest of the main components of milk, the effects of the industrial treatments on them and the main problems that can originate in its technological processing	C2 C6

FROG3: To explain the operations of milk obtaining, collecting and transporting, and how the way of carrying them out affects the quality of the raw material entering the industry				C1 C7 C14
FROG4: To describe the nature and properties of naturally occurring enzymes and microorganisms as contaminants or additives in milk, indicating their possible implication as responsible for alterations or as desirable transformation agents, in the manufacture of dairy products				C1 C2 C6 C7
FROG5: To know the equipment and facilities used in the dairy industry for technological treatments and the packaging of milk, and for manufacturing the different types of dairy products				C6 C7 C14
FROG6: To explain the processes of preservation and diversification of milk: its basis, its particularities, the problems involved, the controls in the manufacturing plants and the characteristics of the different resulting products				C1 C6 C7 C14
FROG7: Ability to take samples of milk and dairy products, and to carry out basic compositional, physicochemical and microbiological analyses				C13 C14
FROG8: Ability to work as a manufacturing or production technician in a dairy industry				C13 C14
FROG9: Ability to standardize and improve productions, and to solve specific problems in the manufacture of dairy products	A2			C14 D5
FROG10: Ability to diagnose and, where appropriate, correct alterations in milk and dairy products	A2	B1		C13 C14
FROG11: Ability to analyze and evaluate food hazards in a dairy industry and to prepare a Hazard Analysis and Critical Control Point (HACCP) manual	A2			C7
FROG12: Ability to relate lactological concepts, and focus the challenges and problems within the scope of the dairy industry in an analytical and pragmatic way	A2	B4		D4 D5
FROG13: Ability to document and discern information of interest with a view to solving specific problems in the dairy industry	A2	B1 B4		D4 D5

Contents

Topic

INTRODUCTION. THE DAIRY SECTOR	INTRODUCTION. BASIC CONCEPTS AND SOCIOECONOMIC ENVIRONMENT. Milk and dairy products: concepts and definitions. Milk Science and Technology: concept and relationships with other sciences and disciplines. The dairy industry in Spain: economic importance of the sector. The dairy sector in Galicia: current situation and prospects.
--------------------------------	---

COMPOSITION AND MILK COMPONENTS.
PROPERTIES OF TECHNOLOGICAL INTEREST

COMPOSITION OF MILK. MINERALS. Components of milk. Factors of variation of the composition. Milk minerals. Factors affecting the mineral composition of milk. Physicochemical equilibria between milk minerals. Trace elements.

THE CARBOHYDRATES OF MILK. Glucidic components of milk. Lactose. Properties of lactose of technological interest: solubility, crystallization, hydrolysis, reducing power and participation in the Maillard reaction. Major problems of lactose in dairy technology. Effects of other industrial treatments on lactose.

THE LIPIDS OF MILK. I. Lipidic components of milk. The fat emulsion of the milk. The fat globule: size, composition, nature of the membrane. Effect of industrial treatments on the fat emulsion: homogenization, agitation, other treatments.

THE LIPIDS OF MILK. II. Lipolytic rancidity of milk. Lipolytic enzymes present in milk: activation and inhibition. Autooxidation of milk lipids. Sensitivity of milk to lipid autooxidation. Intrinsic and extrinsic factors that affect autooxidation of milk fat. Other alterations of milk fat.

THE NITROGENATED COMPONENTS OF MILK. I. Nitrogenated components of milk. Technological interest. Classification. The caseinic fraction of milk. Components of the caseinic fraction. Micellar state of caseins. Structure of the casein micelle. Stability of the casein micelles.

THE NITROGENATED COMPONENTS OF MILK. II. Destabilization of the micelles: action of proteolytic enzymes, acidification, addition of salts, extreme temperatures and concentration. Whey proteins. Non-protein nitrogenated substances. Effects of industrial treatments on nitrogenated substances of milk.

ENZYMES OF INTEREST OF MILK. MILK VITAMINS. Technological interest of dairy enzymes. Classification. Lipases and esterases. Proteases. Phosphates. Xanthine oxidase and superoxide dismutase. Lactoperoxidase and catalase. Sulfhydryl oxidase. Milk vitamins.

PHYSICAL AND PHYSICOCHEMICAL PROPERTIES OF MILK. Interest. pH and titratable acidity. Density or specific gravity. Cryoscopic point. Oxidation-reduction potential. Surface tension and viscosity. Electric conductivity. Specific heat and thermal conductivity.

DAIRY MICROBIOLOGY

DAIRY MICROBIOLOGY. Concept and importance of microbiological quality of milk. Milk as a culture medium. Origin of microorganisms present in milk. Microbial groups of dairy interest. Effects of industrial treatments: refrigeration, heat treatments, homogenization. Microorganisms of technological interest. Legislation: microbiological criteria.

GENERAL OPERATIONS. PACKAGED MILK

COLLECTION AND TRANSPORT OF MILK. RECEPTION AND CONTROL IN THE INDUSTRY. Collection and transport of milk to industry. Organization of the collection. Reception and control of milk in the industry: unloading, entry control, storage and physical purifying. Automated methods of milk analysis.

HYGIENIZED MILK. Definition. Hygienization of milk by pasteurization. Major problems of pasteurization. Low pasteurization and high pasteurization. Manufacture of pasteurized milk: operation of a pasteurizing plant. Other higienization procedures. Packaging of higienized milk. Controls of pasteurized milk.

STERILIZED MILK AND UHT MILK. Definitions. Problems in the manufacture of sterilized and UHT milks. Methods of sterilization. Indirect and direct UHT treatment systems. Aseptic packaging of UHT milk. Controls of UHT milk.

PARTIALLY DEHYDRATED MILK AND POWDERED MILK

PARTIALLY DEHYDRATED MILK. Definitions. Evaporated milk: types and manufacturing technology. Condensed milk: types and manufacturing technology. Treatments, authorized additives and raw materials.

POWDERED MILK. Definition and types. Manufacture of powdered milk. Manufacture of instant powdered milk. Treatments, authorized additives and raw materials.

CREAM AND BUTTER

CREAM. Definition and commercial types of cream. Cream manufacture: skimming, deacidification, pasteurization, homogenization, deodorization, packaging and storage. Treatments, authorized additives and raw materials. Controls at the manufacturing plant.

BUTTER. Definition and types. Manufacture of butter by discontinuous methods. Manufacture of butter by continuous methods. Treatments, authorized additives and raw materials. Controls at the manufacturing plant.

CHEESE, FERMENTED MILKS AND OTHER DAIRY PRODUCTS

CHEESE. I. Definition. Classification of cheeses. General cheese technology: milk selection, pasteurization, coagulation, draining of whey, molding and pressing, salting.

CHEESE. II. Cheese ripening: biochemical phenomena and conditioning factors. Specific technologies for cheese processing. Modern techniques applicable to the manufacture of cheese: continuous methods, centrifugal draining of whey, ultrafiltration. Additives and microbiological criteria.

FERMENTED MILKS. Definition and classification. Milks subjected to acid fermentation: yogurt. Milks fermented with *Lactobacillus acidophilus* and *Bifidobacterium* spp. Milks subjected to acid-alcoholic fermentation. Additives and microbiological criteria.

LABORATORY PRACTISES

COMPOSITIONAL AND PHYSICOCHEMICAL ANALYSIS OF RAW MILK. Determinations of dry matter, fat and protein contents. Determinations of pH, titratable acidity and density.

INDUSTRIAL SUITABILITY OF RAW MILK AND CONTROLS OF HEAT TREATED MILK. Alcohol and reductase (methylene blue) tests. Control of pasteurization: alkaline phosphatase test. Enumeration of aerobic mesophilic microorganisms and enterobacteria in raw and pasteurized milk. Control of heat treatments: peroxidase and Aschaffenburg tests. Determination of proteolytic activity in UHT milk.

MILK PASTEURISATION. Handling a pasteuriser with plate heat exchangers. Raw milk pasteurisation for the manufacture of fermented milk and cheese.

PRODUCTION OF FERMENTED MILKS. Preparation of starter cultures. Manufacture of a firm yogurt. Manufacture of a flavoured yogurt. Manufacture of kefir.

MANUFACTURE OF CHEESE. Determination of coagulant activity or strength of a rennet. Preparation of an acid curd and an enzymatic curd. Manufacture of a mixed-curd cheese. Addition of calcium chloride, starter cultures and rennet. Coagulation and draining of whey. Salting operation. Moulding and pressing operations.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	42	70
Laboratory practical	14	7	21
Seminars	14	7	21
Studies excursion	0	8	8
Mentored work	0	20	20
Problem solving	0	10	10

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Theoretical activity. Explanation by the professor of the contents on the subject, and the theoretical bases and / or guidelines of the works and exercises to be developed by the students
Laboratory practical	Guided practical activity. Acquisition activities of basic and procedural skills related to the subject (analytical determinations, manufacture of small-scale products, quality control tests, etc.). They will take place in the laboratory of Food Technology practices

Seminars	Guided practical activity. Activities focused on the work on a specific topic, which allow to complement or deepen the contents of the subject. They will be used as a complement to the theoretical classes
Studies excursion	Guided practical activity. Activities of application of knowledge to concrete situations. If possible, a visit will be made to a small and a large dairy industry
Mentored work	Autonomous practical activity. Preparation and presentation by students, before the professor and classmates, of a bibliographic review document on a current topic related to the subject. It is an autonomous student activity focused on the search, collection and processing of information, including the reading and management of specialized bibliography (databases, scientific journals). It will be carried out in groups (groups of three / four students), and the works will be presented in hours for seminars (1 hour per group)
Problem solving	Autonomous practical activity. Tasks in which exercises related to the subject are formulated as multiple-choice tests. The student must perform the exercises individually. The tests corresponding to each subject or module in which the subject is structured will be presented through the TEMA on-line teaching platform

Personalized assistance

Methodologies	Description
Mentored work	Specific documentation will be provided. Students will be advised on information search and bibliographic review. The preparation and exposition of the works will be supervised, making the appropriate corrections and suggestions. Personalized attention may take place by telematic means under prior agreement
Problem solving	Clarification of the doubts raised in the resolution of the questionnaires. Personalized attention may take place by telematic means under prior agreement

Assessment

	Description	Qualification	Training and Learning Results		
Lecturing	The knowledge acquired through this teaching methodology will be evaluated by means of an exam of short answer essay questions (final exam)	40			C1 C2 C6 C7 C13 C14
	Learning outcomes assessed: RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9, RA10, R11				
Laboratory practical	The knowledge acquired through this teaching methodology will be evaluated by means of an exam of short answer essay questions (final exam)	10			C7 C13 C14
	Learning outcomes assessed: RA7, RA8, RA9, RA10, RA11				
Seminars	The knowledge acquired through this teaching methodology will be evaluated by means of an exam of short answer essay questions (final exam)	10			C1 C2 C6 C7
	Learning outcomes assessed: RA1, RA2, RA3, RA4, RA5, RA6, RA11				
Mentored work	The preparation and presentation of the work (within a group)	20	A2	B1 B4	D4 D5
	Learning outcomes assessed: R12, RA13, RA14				
Problem solving	The resolution of the proposed exercises (multiple-choice tests) will be evaluated through the on-line teaching platform	20	A2	B1	D4
	Learning outcomes assessed: RA12, RA13				

Other comments on the Evaluation

The preferred evaluation modality is **Continuous Evaluation**. The student who chooses the **Global Evaluation** (100% of the grade obtained in the official exam) must notify the teacher responsible for the subject, either by email or through the Moovi tele-teaching portal, within a period not exceeding one month from the beginning of the teaching of the subject. In the **Continuous Evaluation** modality, the final exam will be considered (to be added to the rest of the scores) provided that a minimum mark of 4 out of 10 is obtained. In the second edition or second evaluation opportunity, the students who request it previously may be evaluated with a single exam of the entire subject, which will represent 100% of the qualification.

Final exam call: the student who chooses to be tested at the end of the course call will be evaluated only by the exam (which will represent 100% of the qualification). In case of not attending this examination, or not passing it, he will be evaluated in the same way as the rest of the students.

Dates of exams: end of the course, 09/21/2023 at 16:00 h; first edition, 01/25/2024 at 10:00 a.m.; second edition, 07/08/2024 at 10:00 p.m. In case of error in the transcription of the examination dates, the valid ones will be the ones officially approved and published in the bulletin board and in the web site of the Center.

Grading system: will be expressed by a numerical final qualification of 0 to 10 according to the current legislation (Spanish Royal Decree 1125/2003 of September 5, B.O.E. of September 18).

Sources of information

Basic Bibliography

GÖSTA BYLUND, M., **Manual de industrias lácteas**, 9788489922815, 3ª, AMV Ediciones - Mundi-Prensa Libros, S.A., 2003
WALSTRA, P.; GEURTS, T.J.; NOOMEN, A.; JELLEMA, A.; VAN BOECKEL, M.A.J.S., **Ciencia de la leche y tecnología de los productos lácteos**, 9788420009612, 1ª, Acribia, S.A., 2001

EARLY, R., **Tecnología de los productos lácteos**, 9788420009155, 2ª, Acribia, S.A., 2000

Complementary Bibliography

MADRID, A., **Tecnología de la leche y los productos lácteos**, 9788412554472, 1ª, AMV Ediciones, 2022

MADRID, A., **Bioquímica de la leche**, 9788412496628, 1ª, AMV Ediciones, 2022

MADRID, A., **La leche y los productos lácteos: composición y procesado**, 9788412309324, 1ª, AMV Ediciones, 2021

MADRID, A., **Métodos de análisis de la leche y los productos lácteos**, 9788412239423, 1ª, AMV Ediciones, 2020

ALVARADO, J. D., **Cálculo de procesos en leche y productos lácteos**, 9788420011837, 1ª, Acribia, S.A., 2018

MEGHWAL, M.; GOYAL, M.R.; CHAVAN, R.S., **Dairy engineering: advanced technologies and their applications**, 9781774637128, 1ª, CRC Press. Taylor & Francis Group, 2017

CHANDAN, R.C.; KILARA, A., **Elaboración de yogur y leches fermentadas**, 9788420011776, 1ª, Acribia, S.A., 2017

TETRA PAK INTERNATIONAL S.A., **Dairy processing handbook**, 9789176111321, 1ª, Tetra Pak, 2015

OZER, B.; AKDEMIR-EVRENDILEK, G., **Dairy microbiology and biochemistry: recent developments**, 9781482235029, 1ª, CRC Press. Taylor & Francis Group, 2014

FAO/OMS, **Leche y productos lácteos: Comisión FAO/OMS del Codex Alimentarius**, 9789253067862, 2ª, FAO y OMS, 2012

JEANTET, R.; ROIGNANT, M.; BRULE, G., **Ingeniería de los procesos aplicada a la industria láctea**, 9788420010502, 1ª, Acribia, S.A., 2005

WALSTRA, P.; WOUTERS, J.T.M.; GEURTS, T.J., **Dairy science and technology**, 9780824727635, 2ª, CRC Press. Taylor & Francis Group, 2005

ROMERO DEL CASTILLO, R.; MESTRES, J., **Productos lácteos: tecnología**, 9788483017456, 1ª, Edicions UPC, 2004

MAHAUT, M.; BRULE, G.; JEANTET, R., **Productos lácteos industriales**, 9788420010144, 1ª, Acribia, S.A., 2003

MAHAUT, M.; JEANTET, R.; BRULÉ, G., **Introducción a la tecnología quesera**, 9788420010137, 1ª, Acribia, S.A., 2003

SCHLIMME, E.; BUCHHEIM, W., **La leche y sus componentes: propiedades químicas y físicas**, 9788420009926, 1ª, Acribia, S.A., 2002

VARNAM, A.H.; SUTHERLAND, J.P., **Leche y productos lácteos: tecnología, química y microbiología**, 9788420007946, 1ª, Acribia, S.A., 1995

LUQUET, F.M., **Leche y productos lácteos: vaca, oveja, cabra. vols. 1 e 2**, 9788420006956 y 9788420007410, 1ª, Acribia, S.A., 1991, 1993

VEISSEYRE, R., **Lactología técnica: composición, recogida, tratamiento y transformación de la leche**, 9788420004587, 2ª, Acribia, S.A., 1988

WALSTRA, P.; JENNES, R.; BADINGS, H.T., **Química y física lactológica**, 9788420005942, 1ª, Acribia, S.A., 1986

ALAIS, C., **Ciencia de la leche: principios de técnica lechera**, 9788429118155, 1ª, Reverté, S.A., 1985

Alimentación, Equipos y Tecnología. Madrid: Alción. ISSN: 0212-1689, 1982-2014

Alimentaria: Revista de Tecnología e Higiene de los Alimentos. Madrid. ISSN: 0300-5755, 1964-

Dairy Foods. BNP Media. ISSN: 0888-0050, 1999-

Dairy Industries International. Bell Publishing Ltd. ISSN: 0308-8197, 1994-

International Dairy Journal. Elsevier Science. ISSN: 0958-6946. Online ISSN: 1879-0143, 1995-

International Journal of Dairy Technology. Wiley-Blackwell. ISSN: 1364-727X. Online ISSN: 1471-0307, 1997-2009

Journal of Dairy Research. Cambridge University Press. ISSN: 0022-0299. Online ISSN: 1469-7629, 1929-

http://www.perseo.biblioteca.uvigo.es/search*spi,

<http://www.scopus.com/home.url>,

<http://bddoc.csic.es>,

<http://www.westlaw.es/wles/app/login/subscription>,

<http://sfx.bugalia.org/vig/az?lang>,

<http://www.fenil.org>,

<http://www.todolacteo.com>,

<http://www.queseros.com>,

<https://www.alfalaval.es>,

<https://www.tetrapak.com/es>,

<https://www.fil-idf.org>,

<http://eda.euromilk.org>,

<http://www.adsa.org>,
<http://www.cdr.wisc.edu>,
cytali@listserv.rediris.es,

Recommendations

Subjects that it is recommended to have taken before

Food chemistry and biochemistry/O01G041V01404

Food technology/O01G041V01502

Raw materials/O01G041V01904
